

THE JOINT TACTICAL RADIO SYSTEM (JTRS)

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Author's Note: The JTRS will be a family of advanced, reliable, and dynamic communication platforms that will be software reprogrammable, multimode capable, and network-able, while simultaneously providing voice, data, and video communications. Its open-system architecture will enable portability of waveforms across JTR systems and technology insertion through evolutionary acquisition or preplanned product improvement.

Introduction

Military engagements present one of the most dynamic and hostile environments for systems deployment and usage. System elements are continually moving, reorganizing, appearing, and disappearing, and the enemy is waging a physical and electronic information battle to destroy these systems. In this type of environment, availability, interoperability, and security are essential.

Legacy System Interoperability

The increase in DOD's communications requirements has led to a large number of various types of radios, each capable of a particular mission and each having unique characteristics for transmission. DOD legacy systems are typically single-band, single-mode radios that have limited expansion capabilities. As a result, legacy systems require complex solutions to be interoperable with other systems and networks. Use of proprietary standards further complicates interoperability, resulting in problems with noninterop-

erable systems that require manual intervention to interchange information. Additionally, warfighters must deploy with a different radio and support equipment for every system needed to interoperate, thus increasing their burden and logistics support. Because of this, requirements for a single radio that could be reconfigured to interoperate with the legacy radio were generated, and private industry responded with unique software-controlled reprogrammable radios. However, the proprietary designs of these radios and legacy radio waveforms perpetuated maintenance and logistical problems without truly providing interoperability.

A Coordinated Effort

Each Service within DOD began separate programs to develop a common radio system that would gain the benefits of software-defined radios (SDRs). The JTRS was initiated to coordinate the efforts of all the Services in development of a single family of interoperable radios. The JTRS Program facilitates development of a single architecture for industry and DOD to build SDRs and waveform applications to interoperate with legacy radios, as well as state-of-the-art waveforms to meet increasing demands for information on a dynamic battlefield. This approach allows the Services to gracefully migrate from existing systems to new capabilities while achieving true interoperability.

Technological Obsolescence

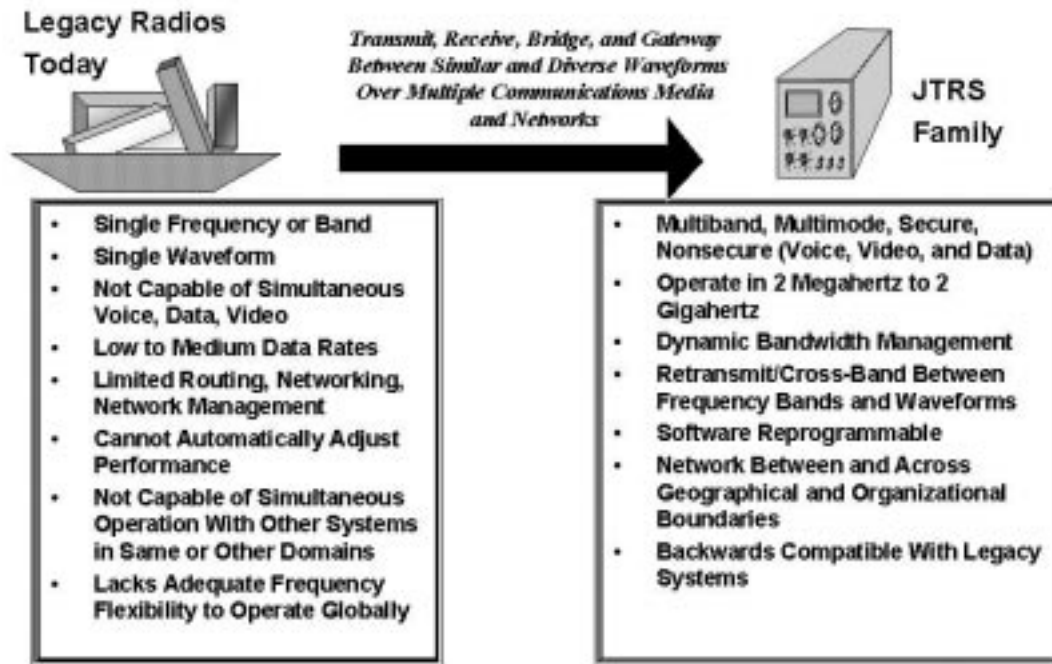
The dramatic pace of advances in communications technology, coupled with the military's traditionally long system-acquisition cycles, has resulted in the technological obsolescence of new systems before they are fielded. Costs have prohibited retrofitting old systems with improved capabilities, resulting in reduced military readiness. Current radio systems cannot be technologically updated cost effectively. SDRs provide the opportunity for "future-proofing" via preplanned product improvements.

The JTRS is being developed as a network-centric family of communication devices for DOD in support of Joint Vision 2020 missions. Network-centric devices focus on networked information rather than on individual radios. The JTRS is expected to provide interoperability across all geographical and organizational boundaries (horizontal, vertical, Service, and national). The JTRS will be capable of transmitting in voice, data, and video formats while operating in frequency bands ranging from 2 megahertz to 2 gigahertz. To facilitate migration into the Services, the JTRS will maintain backwards compatibility with selected legacy waveforms and provide crossbanding between disparate systems.

Centralized Management

The JTRS Program is a series of related but independent joint acquisitions involving program managers from different Services for

JTRS Requirements



decentralized execution and a centralized management process for oversight. The Army is the lead Service for the joint activities. The program acquisition strategy for the JTRS is divided between the Joint Program Office (JPO) and the Services' acquisition centers. The JPO is responsible for defining, developing, validating, and maintaining the software communications architecture (SCA) (or standard) that establishes the interface between the hardware and software, and for acquiring software waveform applications.

The Services are responsible for developing JTRS radio sets—to include porting independently developed waveforms, integrating the waveforms, and fielding the JTRS radio set as a final product for the user. Each of the procurements will be a joint effort, with the acquiring Service acting as the lead Service for each procurement. The lead Service for individual procurements is selected through a management process. The JTRS Program will be developed via a phased implementation effort that balances operational

requirements, weapon system integration issues, and funding constraints.

SDRs are becoming more common. However, they are each built to a different proprietary architecture, have different capabilities, are not adaptable, and are not interoperable. The strength of the JTRS is that it introduces standardized architecture and software waveforms that can be cross-banded to achieve interoperability objectives.

Overall Goal

An overall goal of the JTRS Program is to evolve to where waveform applications are developed once, are "portable" (i.e., can be rehosted to other JTRS sets with minimum effort) to existing and future JTRS radio sets, are easily upgraded, and can address joint requirements across the Services. Underlying drivers for this include joint interoperability, reduction of total ownership costs, and avoidance of technical and operational obsolescence. The JTRS acquisition approach addresses these goals by focusing on

separate acquisition of waveform applications and JTRS sets.

Traditionally, hardware and software have been acquired from the same vendor. This approach does not guarantee any independence of the waveform application and the particular JTRS set. Without this independence, waveform applications will be hardware-specific and will not meet the above goals.

Hardware Versus Software

The proposed acquisition strategy for JTRS is based on the concept of independent hardware and software procurement. In this context (i.e., the JTRS), hardware includes all components and the necessary software infrastructure of an operating system, the core framework (which is the implementation of the standard architecture), and certain functional services required by the software waveform applications. Software includes waveform applications implemented as reusable—portable software applications that are independent of the

hardware host. Each total waveform includes all functionality from the antenna to the end-user equipment.

Modular software radio technology allows for the insertion of new algorithms and technologies, the quantitative characterization of waveform performance, and separation of the waveform definition from implementation details to enhance portability. This can be achieved through development of an open, industry-accepted architecture that provides the framework for developing and evolving a family of software-programmable radios.

The JTRS SCA provides a set of application programming interfaces to standardize system control and inter-processor communications. The SCA is defined around the Portable Operating System Interface Standard applications program to provide for the portability of source-code applications across different operating systems. Common Object Request Broker Architecture (CORBA) middleware standards provide interoperability among applications on different processing machines in heterogeneous-distributed environments and provide for seamlessly interconnecting multiple-object systems.

The JTRS provides a platform for multiple, simultaneous waveform standards and services, where functionality can be changed via software downloads. The benefits include increased flexibility, smaller size, and potentially lower cost. As requirements evolve and services are improved or added, the JTRS can adapt rapidly to new technologies and capabilities without the need for major equipment changes or replacements, thus providing investment protection and quick response to a dynamic tactical environment.

Commercial Investments

The SDR concept has significant application in the commercial marketplace. Therefore, it is desirable that the Services benefit from any advancements made in the private sector in this technology. In addition, technical obsolescence can be managed by leveraging commercial technologies and their market-driven evolution. Again, this can also be addressed through the development of an open, industry-accepted architecture.

Government and industry have formed a Software Defined Radio Forum (SDRF), which acts as a radio standards development body. The SDRF has accepted the JTRS SCA as the basis for further development and standardization. Other standards organizations, such as the Object Management Group and the Institute of Electrical and Electronic Engineers Inc., are being considered for formal standardization of software-radio architectures. Once the SCA has matured, one of these organizations will maintain the JTRS software architecture as a commercial standard. This process avoids the high costs associated with military-unique standards, costs that acquisition reform mandates seek to eliminate.

The acceptance of an industry standard is usually a very lengthy process. Therefore, in practice, a *de facto* standard is accepted rather than first defining and accepting a standard. While there is much interest in the JTRS architecture within the international, commercial industry, there is no guarantee that SCA will be accepted as a standard. The likelihood of SCA being accepted increases as the SDRF continues the formalization of software radio architecture and as the Services proceed with hardware procurements and produce the first few JTRS products.

Conclusion

From the onset of the JTRS Program, the government has encouraged the use of commercial and nondevelopmental items to satisfy the JTRS requirement. Market research and strong interest and involvement by industry in the program have shown that this is a viable concept. The establishment of SCA as the standard by which all DOD-procured radios will be built not only ensures interoperability but also promotes competition. This ensures that government radios will embody leading-edge technologies that are commercially available.

The JTRS concept (i.e., software radio and SDR) has the potential of bringing new capabilities to the battlefield. These new capabilities include:

- Advanced programmable information security capabilities;

- Adaptable frequency reuse and management capabilities;

- Mobile, ad hoc networking capabilities (e.g., the new wideband network waveform); and

- New interoperability solutions (e.g., new cross-banding capabilities for different systems and over-the-air downloadable waveform applications for near real-time upgrades and mission upgrades).

SDRs offer a wide range of capabilities defined in software running on "common" hardware. SDRs allow for improvements or enhancements without altering system design. SDR capabilities also enable users to acquire common hardware and to satisfy individual requirements with software that fits each specific application (as in the personal computer marketplace).

The major advantage of an SDR (i.e., the JTRS) is its ability to be reprogrammed when the situation changes or improved software becomes available. The technological advances taking place in the world today require development of systems that are as flexible and upgradeable as possible. The JTRS encompasses these concepts and provides warfighters a flexible, adaptable communications capability that keeps pace with evolving technology and the changing battlefield environment.

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